Industrial Engineering and Innovation Management (2022)
Clausius Scientific Press, Canada

DOI: 10.23977/ieim.2022.050410
ISSN 2522-6924 Vol. 5 Num. 4

Analysis of Aviation Maintenance Scheme based on Hierarchical Clustering

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Keywords: Hierarchical clustering, Maintenance scheme, R language

Abstract: Aircraft maintenance is a very important and essential festival in aviation activities. Aircraft maintenance directly affects the flight safety of aircraft and the economic benefits of airlines. In actual maintenance activities, there are many factors affecting maintenance, so it is difficult to list them one by one. Even the listed factors cannot be analyzed quantitatively, so it is very unfavorable for the company to formulate maintenance measures. Aviation maintenance quality is directly related to aircraft reliability and safety, and is an important part of aircraft life cycle management. The application of analytic hierarchy process can comprehensively evaluate the quality indicators of each maintenance unit, determine the overall quality of maintenance work, find weak links and further improve. In this study, the hierarchical clustering method is applied to analyze the aviation maintenance scheme, the hierarchical clustering analysis model is established, and the R language analysis software is used for detailed analysis. Through analysis, multiple maintenance schemes are aggregated into simple and representative scheme classes, so as to provide decision-making basis for scheme decision-makers. Practice shows that the method has the advantages of simple principle, easy operation and strong practicability.

1. Introduction

Aircraft maintenance is not only directly related to flight safety, but also directly affects the operation cost of the company. There are many factors affecting aircraft maintenance, and different factors have different effects on aircraft maintenance. To realize the timely control of safety events, reduce flight safety hazards and improve the economic benefits of airlines, the key lies in formulating effective measures. When formulating measures, we need to comprehensively consider their influencing factors. Among the many influencing factors, we need to find out the key factors and formulate special measures according to the size of each influencing factor. Cluster analysis, also known as group analysis, is widely used in multivariate statistical analysis. Its basic principle is to apply measurement standards according to the numerical characteristics of things to measure the degree of closeness between samples, and those close to each other are classified into one category. His philosophy is that birds of a feather flock together. Cluster analysis is a data reduction technology, which can reduce a large number of sample values into several classes. The similarity of similar sample values is greater than that of different sample values. R language is one of the

most popular data analysis platforms so far. Because it is free and open-source, and provides versions of windows, Mac OS X and Linux systems at the same time, it is favored by the majority of scientific researchers. The official website of R language regularly provides various updated data packages, which is more convenient to use.

2. Cluster Analysis

Cluster analysis is to group the things of physical or abstract objects into multiple classes composed of similar objects, so as to find the characteristics of different classes and better understand the real face of things. The specific steps of cluster analysis are as follows: (1) select the appropriate variable indicators. The characteristics of anything can be described in detail through several or more variable indicators. Whether the indicators are selected correctly or not is related to the accuracy of the analysis results. (2) standardized variable data. In order to accurately measure the role of each index, different indexes need to be standardized. In this way, the indexes in different numerical ranges are unified, and the algorithm operation can be carried out accurately. (3) calculate the similarity. The similarity between samples can be measured by distance. The commonly used distances are Euclidean distance, Manhattan distance, Chebyshev distance and so on. (4) select the clustering algorithm. If the number of samples is small, hierarchical clustering algorithm is suitable; The division method is suitable for the situation that the number of clusters has been clear and the number of samples is generally large. (5) determine the number of classes. Try the number of different classes, analyze the quality of the solution, and finally determine the number of classes. (6) result visualization. The result of hierarchical clustering is generally a tree view, and visualization can more clearly understand the classification of samples. (7) analysis results. Analyze the determined class and analyze the class in the physical sense, so as to better understand the scientificity of the method[1].

3. Hierarchical Cluster Analysis

There are two common methods of cluster analysis: hierarchical clustering and partitioned clustering. The difference is that the former does not specify the number of classes in advance. In the clustering process, each observation value forms a class from bottom to top and combines two by two according to the algorithm until all classes are gathered into one class; The latter is to specify the number of classes in advance according to the specific actual situation of things, and then the observed values are seated according to the number[2]. There are two common patterns of hierarchical clustering: one is from bottom to top, starting from points as a class, merging two nearest classes in each step until it is one class; The other is from top to bottom. Each step is divided into one class until it is a single point. In practical application, hierarchical clustering results are often represented by tree view, which has the advantages of eye-catching and easy to understand, and the similarity between each class and other classes is clearly visible. The distance between samples Xi and XJ is

$$DIJ(q)= \Sigma nk = 1 xik - xjk \{ q \}1 /q \quad (1).$$

Equation (1) is Minkowski distance. The details are as follows: (1) when q = 1, it is called absolute distance or Manhattan distance. (2) when q = 2, it is called Euclidean distance. (3) when q = 3, it is called Chebychev distance[3].

Therefore, the so-called distance can be called dissimilarity measure or difference measure. Generally, Euclidean distance is mainly used to measure numerical variables. If the similarity of two different classes is defined as the shortest distance between any two points in the two classes, this calculation method is called single chain method, which is more suitable for dealing with non

elliptical classes, but not in the case of noise or outliers. If the similarity of two different classes is defined as the longest distance between any two points in the two classes, this calculation method is called the full chain method, which is more suitable for dealing with spherical classes and is less sensitive to noise or outliers[4]. The tradeoff between the two is the average calculation method. The similarity of two different classes is defined as the average distance between all points in the two classes, also known as unweighted pair group method using arithmetical average (UPGMA). This method has less tree distortion than other algorithms. Euclidean distance is often used to calculate quantitative data, while Jaccard and dice (soren-son) can be used for qualitative data. The main steps of hierarchical cluster analysis: (1) define each observation vector as a class. (2) calculate the distance between each type and other types. (3) merge the shortest distance category 2 into category 1. (4) repeat steps (2) and (3) until all classes are aggregated into class 1[5].

4. Aviation Maintenance Scheme Analysis

Aviation maintenance plan refers to the planned maintenance inspection requirements formulated by the civil aviation operator or user according to the aircraft configuration, operation environment and maintenance experience to implement the aviation maintenance outline, airworthiness and operation regulations and requirements, as well as the manufacturer's suggestions[6]. Scientific analysis and evaluation of maintenance schemes is of great practical significance to improve aviation service quality and maximize profits for maintenance enterprises. When analyzing the aviation maintenance scheme, the important task is to select a satisfactory scheme to achieve the decision-making goal from the candidate schemes under certain constraints. Generally speaking, it is to choose the best under the restriction of multiple elements. The main indicators of Aviation Maintenance Scheme include technical value, technical complexity, technical feasibility, technical maturity and technical standards[7]. The essence of analyzing aviation maintenance schemes is to analyze the essence of the above indicators, abstract each maintenance scheme into a multivariate vector, cluster analyze all maintenance schemes by using hierarchical clustering method, and divide the schemes with high similarity into one group, so as to realize the purpose of simplifying scheme analysis and better provide decision support for decision analysts.

The analysis steps of aviation maintenance scheme based on hierarchical clustering method are as follows: (1) construct the analysis scheme. According to the actual situation of aviation maintenance, representative attribute indexes are selected to construct the analysis scheme. (2) establish aviation maintenance plan. Based on the idea of hierarchical clustering method, the analysis model applies hierarchical clustering method to analyze the maintenance scheme. (3) use the analysis model for classification. In different maintenance schemes, some schemes have large similarity, so they can be classified to simplify the analysis. The hierarchical clustering method is applied to analyze the aviation maintenance scheme, determine different classes, and analyze the results[8].

5. Conclusion

Aviation maintenance quality refers to the sum of the characteristics that the maintenance activities implemented by the maintenance subject to the maintenance object meet the requirements of equipment operation safety and reliability. With the in-depth development of modern aircraft complexity, intelligence and systematization, maintenance support has become an important part of aircraft life-cycle use, which is directly related to aircraft reliability, utilization rate and economic benefits. In order to ensure flight safety, the maintenance quality of aviation maintenance units must be effectively managed, assessed and comprehensively evaluated. Cluster analysis method has been widely used in many fields and has achieved great economic value. Cluster analysis method has

been widely used in many fields and has achieved great economic value. The hierarchical clustering method is easy to understand and has strong operability. It mines the laws contained in different maintenance schemes according to the data characteristics, finds that there are great similarities between different schemes, classifies and analyzes them, so as to achieve the purpose of reducing complexity to simplicity, so as to better make decisions for maintenance decision-makers quickly, and then improve the aviation maintenance support ability.

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